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30 Apr 96

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FROM: Capt Marla J. De Jong
AFIT Student at the University of Maryland at Baltimore
145 Wimbledon Lane
Owings Mills, MD 21117-4437

SUBJECT: Thesis

1. Enclosed is a copy of my thesis and an extra copy of the abstract. The references are included in the thesis. The following is the remainder of the information that you need:

a. Author: Marla Jean De Jong
b. Military Rank: Captain
c. Service Branch: Air Force
d. Date: 1996
e. Number of Pages: 62 plus 10 introductory pages (title page, table of contents, acknowledgments etc.).
f. Degree Awarded: Master of Science
g. Name of Institution: University of Maryland at Baltimore

2. Please feel free to contact me if you have an questions. My home telephone number is (410) 654-0564.

Marla J DeJong

MARLA J. DE JONG, Capt, USAF, NC
AFIT Student

ABSTRACT

Title of Thesis: Predictors of Atrial Arrhythmias for Patients Undergoing Coronary Artery Bypass Grafting

Marla Jean De Jong, Master of Science, 1996

Thesis directed by: Patricia Gonce Morton, PhD, RN
Associate Professor and Coordinator
Trauma/Critical Care Nursing
School of Nursing

Coronary artery bypass grafting (CABG) is a commonly used and effective procedure to treat coronary artery disease. Atrial arrhythmias are common after CABG. The purpose of this descriptive study was to identify demographic, preoperative, intraoperative, and postoperative factors that predict atrial arrhythmias for post-CABG patients. The convenience sample consisted of 162 CABG patients who were in sinus rhythm preoperatively. Patients were observed postoperatively for the development of atrial arrhythmias. Data were collected using a prospective chart review. Fifty-two patients (32.1%) developed postoperative atrial arrhythmias. Of patients who developed these arrhythmias, the arrhythmia occurred on the second or third postoperative day. Univariate predictors of postoperative atrial arrhythmias included age (p = <.001) and presence of right coronary artery disease (p = .004). Multivariate predictors of postoperative atrial arrhythmias included age (odds ratio by decade = 1.93, 95% confidence interval 1.86-2.00, p = .0007) and right coronary artery disease (odds ratio = 2.67, 95% confidence interval 1.14-6.23, p = .02). This model was 69.8% accurate in predicting postoperative atrial arrhythmias. The results of this study indicate that age and right coronary artery disease can be used to identify patients at increased risk for atrial arrhythmias after CABG.

APPROVAL SHEET

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ABSTRACT

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PREDICTORS OF ATRIAL ARRHYTHMIAS FOR PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING

by
Marla Jean De Jong

Thesis submitted to the Faculty of the Graduate School
of the University of Maryland in partial fulfillment
of the requirements for the degree of
Master of Science
1996

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Chapter I

INTRODUCTION

Statement of the Problem

Coronary artery bypass grafting (CABG) has become a commonly used and effective procedure to treat coronary artery disease for 309,000 patients annually in the United States (Michelson, Morganroth, & MacVaugh, 1979; Yousif, Davies, & Oakley, 1990; Lauer, Eagle, Buckley, & DeSanctis, 1989; Clochesy, Breu, Cardin, Rudy, & Whittaker, 1993; American Heart Association, 1995). Although CABG is generally well-tolerated, with a morbidity rate of only 1% to 6%, postoperative complications are a clinical concern (Lauer et al., 1989; Saloman, 1993). The most frequent postoperative complication after CABG, and a notable cause of variance from the postoperative clinical pathway, is cardiac dysrhythmia (Saloman, 1993). Atrial arrhythmias, such as atrial fibrillation and atrial flutter, are the most common with a reported incidence of 10% to 63% (Dixon, Genton, Vacek, Moore, & Landry, 1986; Fuller, Adams, & Buxton, 1989; Leitch, Thomson, Baird, & Harris, 1990). Postoperative atrial arrhythmias rarely lead to catastrophic outcomes; however, they are difficult to treat and may result in the following: patient anxiety or discomfort; prolonged Intensive Care Unit (ICU) and hospital stay; rehospitalization; increased cost; hemodynamic compromise; stroke; systemic or cerebral embolism; ventricular arrhythmias; permanent cardiac pacing; congestive heart failure; pneumonia; and long-term anticoagulant therapy (Leitch et al., 1990; Lowe, Hendry, Hendrickson, & Wells, 1991; Frost et al., 1992; Nyström, Edvardsson, Berggren,

Pizzarelli, & Rådegran, 1993; Steinberg et al., 1993; Salem et al., 1991; Creswell, Schuessler, Rosenbloom, & Cox, 1993). Many theories about the cause of atrial arrhythmias after CABG have been proposed; however, definitive characteristics that predict the occurrence of atrial arrhythmias have not been identified (Leitch et al., 1990; Fuller et al., 1989; Cox, 1993; Dixon et al., 1986; Rubin, Nieminski, Reed, & Herman, 1987; Yousif et al., 1990; Mendes et al., 1995; Lauer et al., 1989; Creswell, Schuessler, Rosenbloom, & Cox, 1993). Possible causes that have been proposed include intraoperative ischemia, underlying conduction abnormalities, preexisting cardiac disease, and postoperative inflammation (Cox, 1993; Creswell et al., 1993). Additionally, there is no consensus about how to prevent postoperative atrial arrhythmias (Fuller et al., 1989; Lowe et al., 1991; McAlister, Luke, Whitlock, & Smith, 1990; Parker et al., 1983; Dixon et al., 1986; Frost et al., 1992). The ability to identify patients at risk for postoperative atrial dysrhythmias and the subsequent development of effective prophylactic protocols would be extremely useful in guiding the medical and nursing management of patients undergoing CABG.

Purpose and Significance of the Study

The major purpose of this study was to describe and identify predictors of atrial arrhythmias (atrial fibrillation and atrial flutter) in post-CABG patients. Through a clearer understanding of the characteristics of patients who develop atrial arrhythmias, patients at risk for this post-CABG complication can be identified. Additionally, appropriate nursing

and medical protocols for the prevention and/or management of atrial arrhythmias can be developed.

This study impacts managed care, discharge planning, utilization management, and clinical pathway development in a variety of ways. First, the results are useful to identify patients at risk for atrial arrhythmias so that clinicians and utilization managers know what to expect about a patient's course of recovery, length of Intensive Care Unit (ICU) and hospital stay, and appropriate length of telemetry monitoring. Second, atrial arrhythmias often cause patients to deviate from the expected clinical pathway and result in the potential for more serious complications and increased cost. These data will guide the development or refinement of clinical pathways and help anticipate variance from the clinical pathway. Third, since atrial arrhythmias may occur late in a patient's hospitalization, these data can aid healthcare professionals in discharge planning and discharge teaching.

The results of this study may help identify patients at risk for postoperative atrial arrhythmias and the aid subsequent development of effective prophylactic protocols. These protocols would be extremely beneficial in guiding the medical and nursing management of patients undergoing the CABG procedure.

Research Questions

1. What is the incidence of atrial arrhythmias in post-CABG patients?
2. Which demographic, preoperative, intraoperative, and postoperative variables predict the development of atrial arrhythmias in the post-CABG patient?

3. Is there a significant difference in the average length of hospital and ICU stay for patients who develop post-CABG atrial arrhythmias versus patients who do not develop post-CABG atrial arrhythmias?

4. On which postoperative day are atrial arrhythmias most likely to occur?

Summary

Coronary artery bypass grafting is widely used to treat patients with coronary artery disease. The most common complication after CABG is cardiac arrhythmias. Definitive patient characteristics that predict the development of atrial arrhythmias postoperatively have not been identified. This study describes and identifies predictors of atrial arrhythmias for post-CABG patients.

Chapter II

LITERATURE REVIEW

Efforts to identify demographic, preoperative, intraoperative, and postoperative factors predictive of atrial arrhythmias in the postoperative CABG patient have been extensive. Despite these efforts, few consistent patterns have emerged and an understanding of the role of these factors remains elusive.

Demographic Factors

Numerous studies have focused on preoperative patient factors that may contribute to postoperative atrial arrhythmias. The patient's age has been found to be the strongest independent preoperative predictor for the development of atrial arrhythmias after CABG (Fuller et al., 1989; Leitch et al., 1990; Frost et al., 1992; Mendes et al., 1995; Creswell et al., 1993). For each 10-year increment in age, a 1.7-fold to 2.2-fold increase in the risk of atrial fibrillation occurs (Leitch et al., 1990; Mendes et al., 1995). In contrast, Rubin et al. (1987) and Steinberg et al. (1993) reported no association between a patient's age and the risk of developing atrial arrhythmias after CABG.

Male gender has been shown by some investigators to be a predictor of atrial arrhythmias after CABG (Fuller et al., 1989; Salem et al., 1991; Creswell et al., 1993; Mendes et al., 1995). Other researchers have not demonstrated that gender predicts atrial arrhythmias after CABG (Steinberg et al., 1993; Dixon et al., 1986; Crosby, Pifalo, Woll, & Burkholder, 1990; Rubin et al., 1987).

Creswell and colleagues (1993) are the only researchers known to this writer who examined race as a predictor of postoperative atrial arrhythmias. The researchers reported no significant association between race and the incidence of atrial fibrillation post-CABG.

Preoperative Factors

Past medical surgical history. Numerous researchers have investigated the relationship between the patient's past medical/surgical history and the development of atrial arrhythmias post-CABG. Leitch et al. (1990) found patients with chronic renal failure and chronic airflow limitation to be at increased risk for atrial arrhythmias after CABG; however, the value of this finding is limited related to the low prevalence of these conditions in the study group and the small increase of risk for atrial arrhythmias if these diseases were present. Creswell et al. (1993) identified peripheral vascular disease and chronic obstructive pulmonary disease (COPD) as predictors of postoperative atrial arrhythmias for CABG patients. Cigarette smoking was a significant predictor of atrial arrhythmias for CABG patients, but not for all patients who had cardiac surgery requiring cardiopulmonary bypass (Creswell et al., 1993). Postoperatively, atrial arrhythmias occurred less often when the patient had high preoperative glycogen levels (Lolley, Ray, Myers, Sautter, & Tewksbury, 1979).

Past cardiac history. The impact of underlying cardiac disease as a predictor of atrial arrhythmias for the CABG patient has been studied extensively. A history of rheumatic heart disease, myocardial infarction, previous CABG, atrial fibrillation, congestive heart failure, mitral regurgitation, diabetes, hypertension, unstable angina,

extent of coronary artery disease, and elevated left ventricular end diastolic pressure were all found not to be related to the development of postoperative atrial fibrillation (Leitch et al., 1990; Mendes et al., 1995; Creswell et al., 1993; Crosby et al., 1990; Dixon et al., 1986; Fuller et al., 1989). Dixon et al. (1986) documented cardiomegaly and left atrial enlargement to be associated with an increased risk for atrial arrhythmias. Right coronary artery disease was identified as an independent predictor of atrial arrhythmias after CABG (Mendes et al., 1995). Yousif et al. (1990) found the incidence of supraventricular arrhythmias to be significantly higher for patients who had demonstrable myocardial ischemia prior to CABG. Post-CABG patients with atrial arrhythmias had left ventricular hypertrophy on their preoperative electrocardiogram (ECG) and a significantly lower ejection fraction (Steinberg et al., 1993). Each of the above predictors, however, has been documented in isolated studies, so the clinical value of the findings remains in question. Some investigators reported a relationship between COPD, left ventricular ejection fraction, preoperative hypoxemia, and the onset of post-CABG atrial arrhythmias whereas other studies found no association (Yousif et al., 1990; Mendes et al., 1995; Creswell et al., 1993; Dixon et al., 1986; Steinberg et al., 1993).

Medications. The influence of preoperative medications on the development of atrial arrhythmias post-CABG also has been examined. Creswell et al. (1993) found preoperative use of digoxin to be a significant predictor of postoperative atrial fibrillation; however, Dixon et al. (1986) and Fuller et al. (1989) reported no relationship between preoperative use of digoxin and postoperative atrial fibrillation. Parker and associates

(1983) found that patients who received preoperative and postoperative oral digoxin had significantly fewer supraventricular arrhythmias after CABG. Leitch et al. (1990) found the use of preoperative beta blockers predicts the incidence of post-CABG atrial arrhythmias; however, Yousif et al. (1990) concluded that preoperative beta blockers provided significant protection from atrial arrhythmias. The value of preoperative beta blockers is controversial (Mendes et al., 1995; Lauer et al., 1989; Fuller et al., 1989). Patients who received preoperative diltiazem had significantly less supraventricular tachycardia after CABG (Nally, Dunbar, Zellinger, & Davis, 1996). No significant association has been demonstrated between the use of Verapamil, Nifedipine, or diuretics and the development of post-CABG atrial arrhythmias (Leitch et al., 1990; Fuller et al., 1989).

Electrophysiologic factors. A patient's vulnerability for the development of atrial arrhythmias is believed to be related to the lack of uniformity in the distribution of local atrial refractory periods (Cox, 1993). This lack of uniformity cannot be detected on routine electrocardiograms, but can be documented on a P-wave signal-averaged electrocardiogram (Guidera & Steinberg, 1993; Fukunami et al., 1991). The P-wave signal-averaged electrocardiogram has been shown to be a valid and reliable indicator of the lack of uniformity in the distribution of local atrial refractory periods (Guidera & Steinberg, 1993; Fukunami et al., 1991). The mean filtered and unfiltered P wave duration as measured by signal-averaged EKG was significantly prolonged in the X, Y,

and Z leads in patients with atrial fibrillation compared to control patients (Guidera & Steinberg, 1993; Fukunami et al., 1991).

Lowe et al. (1991) investigated a new, intraoperative, electrophysiologic screening test to identify patients at risk for postoperative atrial arrhythmias. Before patients were placed on cardiopulmonary bypass, the physician attempted to induce atrial fibrillation by stimulating the patient's right atrial free wall with increasing amounts of alternating current. Ninety-four percent of the patients who developed atrial arrhythmias postoperatively had atrial fibrillation induced; 41% of the patients who did not develop postoperative atrial arrhythmias did not have atrial fibrillation induced. The researchers concluded that this screening test may be useful to identify patients at risk for atrial arrhythmias after CABG.

Steinberg et al. (1993) prospectively explored the value of the P-wave signal-averaged electrocardiogram as a means to predict atrial arrhythmias after cardiac surgery. The data indicated that P-wave duration on the signal-averaged ECG was the only variable independently predictive of atrial fibrillation. The likelihood of developing postoperative atrial fibrillation was increased 3.9 fold when the signal-averaged P wave duration was prolonged > 140 milliseconds compared with patients in whom the P wave duration was not prolonged > 140 milliseconds. Patients who developed atrial arrhythmias had a significantly lower ejection fraction and significantly more left ventricular hypertrophy on the electrocardiogram; however, these factors alone did not predict P-wave duration or improve prediction when combined with the P-wave duration.

Fukunami and colleagues (1991) examined whether patients at risk for atrial arrhythmias can be detected while in sinus rhythm with a signal-averaged electrocardiogram triggered by P waves. The duration of the filter P wave was significantly longer for patients who developed atrial arrhythmias postoperatively. The differences between the groups remained significant even after controlling for the presence or absence of organic heart disease. The researchers concluded that patients at risk for atrial arrhythmias could be detected while in sinus rhythm by using the P wave-triggered signal-average electrocardiogram.

Buxton and Josephson (1981) evaluated whether intra-atrial conduction defects present on a standard preoperative ECG could predict postoperative atrial fibrillation and atrial flutter in CABG patients. They defined an intra-atrial conduction defect as the mean total P-wave duration measured from the standard limb leads I, II, III. The mean total P wave duration for patients with post-CABG atrial arrhythmias was 126 msec compared to 116 msec for patients without these arrhythmias ($p < 0.001$). Although statistically significant, the predictive value of this variable was minimal. When the P-wave duration was measured for lead II only, the duration did not predict postoperative atrial arrhythmias (Steinberg, 1993; Buxton & Josephson, 1981).

Many preoperative history predictors have been examined in isolated studies, thus limiting the generalizability of the findings. Additionally, the clinical value of the results remains in question. Some predictors such as history of COPD, left ventricular ejection fraction, and preoperative hypoxemia were investigated in more than one study.

Conflicting results were reported which again make it difficult to use the findings in clinical practice.

Intraoperative Factors

The effect of intraoperative factors on the patient's risk for atrial arrhythmias postoperatively also has been examined. Yousif et al. (1990) found that patients who received intraoperative topical cooling had a significantly higher incidence of supraventricular arrhythmias postoperatively. Patients whose intraoperative ischemic time was greater than 56 minutes or who had a bundle branch block were at increased risk for atrial arrhythmias (Ormerod, McGregor, Stone, Wisbey, & Petch, 1984).

A review of the literature reveals clinicians are concerned that the atria may not be fully protected with commonly used cardioplegic solutions during the CABG procedure. With the increased use of cold cardioplegic techniques in the late 1970s, there was a comparable increase in the incidence of atrial arrhythmias (Cox, 1993). With the use of cold cardioplegic techniques, surgeons are able to deprive the heart of its blood supply for a continuous period of up to an hour or more (Cox, 1993). Theoretically, this prolonged ischemia is counterbalanced by the myocardium's decreased energy requirements from the hypothermia and total electromechanical arrest achieved with the use of cold cardioplegia (Cox, 1993). However, the profound myocardial hypothermia and electromechanical arrest are achieved in the ventricular myocardium, but not necessarily in the atria thus resulting in atrial ischemia (Cox, 1993). Postoperative atrial fibrillation may result from

the atria not being protected adequately from ischemic injury during periods of cardioplegic arrest (Cox, 1993).

Mullen et al. (1987) studied the role of cardioplegia on atrial protection and postoperative arrhythmias. Patients were randomly assigned to receive either blood cardioplegia, crystalloid cardioplegia, or diltiazem crystalloid cardioplegia. Only diltiazem crystalloid cardioplegia significantly reduced atrial activity during cardioplegic arrest. Postoperative supraventricular arrhythmias occurred significantly more in the crystalloid cardioplegia group than the other two groups.

Numerous other intraoperative factors have been studied as predictors of post-CABG atrial arrhythmias and include: aortic cross clamp time, number of grafts, perioperative myocardial infarction, time of extracorporeal circulation, acid-base balance, use of defibrillator, use of ventricular pacing, type of grafts, number of distal anastomoses, and surgeon performing the CABG. None of these factors has been found to be associated with postoperative atrial arrhythmias (Leitch et al., 1990; Mendes et al., 1995; Creswell et al., 1993; Crosby et al., 1990; Dixon et al., 1986; Fuller et al., 1989; Fanning et al., 1991; Rubin et al., 1987; Steinberg et al., 1993; Salem et al., 1991; Laub et al., 1993; Vecht et al., 1986).

Postoperative Factors

A sizable number of postoperative factors also have been studied to determine if they contribute to postoperative atrial arrhythmias. Fanning et al. (1991) examined whether prophylactic postoperative magnesium administration could reduce the incidence

of atrial arrhythmias after CABG. While they found no significant difference in the *number* of patients who developed atrial arrhythmias, patients who received supplemental magnesium had fewer *episodes* of atrial arrhythmias, tolerated atrial arrhythmias better, and were easier to treat. Of the 49 patients in the study group, seven patients had 12 episodes of atrial fibrillation and of the 50 patients in the control group, 14 patients experienced 42 episodes of atrial fibrillation. Nine of the 14 control patients experienced persistent or recurrent atrial fibrillation which required multiple drug therapy and/or synchronized cardioversion.

Nally et al. (1996) examined whether postoperative fluid and electrolyte factors contribute to postoperative atrial arrhythmias. Patients who received boluses of potassium, over and above the usual amount of potassium in intravenous fluids, had a significantly higher incidence of atrial arrhythmias. Patients had significantly more postoperative atrial arrhythmias when they lost more than 100 milliliters (ml) of blood from their chest tube for at least 1 hour postoperatively. When patients had a urine output of more than 300 ml per hour for longer than 9 hours, they had an increased incidence of postoperative atrial arrhythmias.

The use of beta blockers after CABG has been shown to protect patients from atrial arrhythmias (Mendes et al., 1995; Fuller et al., 1989; Rubin et al., 1987; Vecht et al., 1986; Matangi et al., 1985; Nyström et al., 1993). The beta blocker timolol significantly reduced the likelihood that a patient would develop atrial arrhythmias after CABG (Vecht et al., 1986). These researchers randomly assigned patients to receive either oral timolol

or a placebo approximately 24 hours postoperatively. Atrial arrhythmias occurred significantly less in patients who received timolol. Patients who received postoperative beta blockers had 0.4 times the odds of developing postoperative atrial arrhythmias as patients left untreated; however, beta blockers were less effective for older patients (Mendes et al., 1995).

Laub et al. (1993) evaluated whether prophylactic procainamide prevented postoperative atrial fibrillation after myocardial revascularization. The researchers found that postoperative patients who received procainamide within 1 hour of admission to the Intensive Care Unit had significantly fewer *episodes* of atrial fibrillation.

None of the following postoperative factors have been associated with the development of postoperative atrial arrhythmias: postoperative hemorrhage, postoperative myocardial infarction, infection, embolism, stroke, bundle branch block, ventricular arrhythmias, pneumonia, reexploration, low cardiac output, postoperative congestive heart failure, postoperative tamponade, recurrent angina, thromboembolism, wound inflammation or drainage, pneumothorax, pericarditis, creatine kinase values, and hemoglobin and hematocrit on the third postoperative day (Dixon et al., 1986; Fuller et al., 1989; Rubin et al., 1987; Michelson et al., 1979; Frost et al., 1992; Crosby et al., 1990).

Summary

Atrial arrhythmias in the post CABG patient are frequent and problematic. Extensive research has been conducted to identify the demographic, preoperative,

intraoperative, and postoperative factors that predict the development of atrial arrhythmias after CABG; however, there is little consensus about the answer to this mystery. Further research is needed to understand the problem and to clearly identify the demographic, preoperative, intraoperative, and postoperative characteristics that predispose patients to atrial arrhythmias post-CABG.

Chapter III

METHODOLOGY

Introduction

A descriptive study using a prospective chart review was conducted to examine the demographic, preoperative, intraoperative, and postoperative factors that predict atrial arrhythmias in the post-CABG patient. This chapter will provide a discussion of the research questions, operational definitions of variables, sampling methods, procedures, pilot testing, protection of human rights, and data analysis.

Research Questions

The following research questions were examined:

1. What is the incidence of atrial arrhythmias in post-CABG patients?
2. Which demographic, preoperative, intraoperative, and postoperative variables predict the development of atrial arrhythmias in the post-CABG patient? Demographic variables included gender, age, diagnosis, and race. Preoperative variables included history of COPD, cigarette smoking, chronic renal failure, and peripheral vascular disease; presence of cardiomegaly, left atrial enlargement, right coronary artery disease, left ventricular hypertrophy; use of preoperative digoxin and preoperative beta blockers; left ventricular ejection fraction and urgency of the CABG operation. The intraoperative variable was the number of grafts performed. Postoperative variables included postoperative beta blocker therapy, cerebral vascular accident, ventricular tachycardia, ventricular fibrillation, temporary pacing, and permanent pacing.

3. Is there a significant difference in the average length of hospital and ICU stay for patients who develop post-CABG atrial arrhythmias versus patients who do not develop post-CABG atrial arrhythmias?

4. On which postoperative day are atrial arrhythmias most likely to occur?

Operational Definitions of Variables

Demographic operational definitions.

Age: the patient's age in years on the day of operation.

Gender: the patient's sex - male or female.

Race: the patient's racial or ethnic group as documented in the chart. The following classifications were used: Caucasian, Black, Asian, Hispanic, and other.

Preoperative data operational definitions.

History of COPD: any patient who had a history of preoperative COPD documented on their history and/or physical.

History of smoking: classified as a nonsmoker, past smoker, or current smoker. A patient who smoked within one month of surgery was considered a current smoker.

History of chronic renal failure: any patient who had a history of preoperative chronic renal failure documented on their history and/or physical.

History of peripheral vascular disease: any patient who had a history of peripheral vascular disease documented on their history and/or physical.

Radiographic cardiomegaly: any patient who had hypertrophy of the heart documented on a chest x-ray report, ECG report, or physician's progress note.

Left atrial enlargement: any patient who had left atrial enlargement documented on an echocardiogram report, ECG, or physician's progress note.

Left ventricular ejection fraction: the percentage (%) of total ventricular blood volume ejected from the heart during each contraction as measured and documented by cardiac catheterization.

Right coronary artery disease: ≥ 70% lumen diameter narrowing of the proximal or mid segment of the right coronary artery as measured and documented by cardiac catheterization.

Left ventricular hypertrophy: any patient with left ventricular hypertrophy documented on an echocardiogram, ECG, x-ray report, or physician's progress note.

Preoperative use of digoxin: documented treatment with digoxin anytime within 1 week prior to CABG.

Preoperative use of beta blockers: documented treatment with any beta blocker anytime within 1 week prior to CABG.

Urgency of CABG procedure: emergent (CABG done immediately without delay) or elective (scheduled CABG or performed when convenient).

Intraoperative data operational definitions.

Number of grafts: the total number of anastomoses that were completed during CABG.

Postoperative data operational definitions.

Postoperative Atrial Arrhythmias: hospitalized, postoperative CABG patients who demonstrated more than 5 minutes of documented atrial fibrillation or atrial flutter on the cardiac monitor post-CABG. Most patients with more than 5 minutes of atrial arrhythmias require treatment for the arrhythmia. All patients had continuous electrocardiographic monitoring during hospitalization.

Postoperative beta blocker therapy: postoperative treatment with beta blocker medication(s) for any length of time after CABG.

Length of stay: the total number of postoperative "midnights" the patient was hospitalized. (If a patient was admitted on Sunday and discharged on Friday the length of stay was five days.)

ICU length of stay: the total number of postoperative "midnights" the patient was in ICU. (If a patient was admitted to the ICU following surgery on Monday and transferred out of ICU on Wednesday, the ICU stay equaled two days.)

Postoperative cerebral vascular accident: a new, postoperative stroke documented on a computed tomography (CT) or magnetic resonance image (MRI) report or by physician's diagnosis.

Postoperative ventricular tachycardia: hospitalized, postoperative CABG patients who demonstrated more than 30 seconds of documented ventricular tachycardia on the cardiac monitor post-CABG. All patients had continuous electrocardiographic monitoring during hospitalization.

Postoperative ventricular fibrillation: hospitalized, postoperative CABG patients who demonstrated documented ventricular fibrillation on the cardiac monitor. All patients had continuous electrocardiographic monitoring during hospitalization.

Postoperative need for temporary pacing: hospitalized, postoperative CABG patients who required documented temporary pacing for any length of time. (Pacing needed to actually occur, i.e., this was not just the presence of pacing wires connected and ready to function if needed).

Postoperative need for permanent pacing: hospitalized, postoperative CABG patients who required implantation of a permanent pacemaker or an automatic implantable cardioverter defibrillator with a pacemaker component.

Sample

A convenience, nonprobability sample of 162 adult CABG patients at the University of Maryland Medical System were enrolled in the study. Because a minimum of 10 subjects per variable are needed for regression analysis, a sample size of at least 150 patients was needed (Pedhazur, 1982). Annually, more than 26,000 patients from a four-state area receive medical care at this hospital. This facility is a major teaching hospital for physicians, nurses, and other healthcare personnel. Approximately 625 CABG procedures are performed at the University of Maryland Medical System annually.

All patients who had a CABG operation between October 30, 1995 and December 13, 1995 and between January 12, 1996 and February 17, 1996 were enrolled in the study.

The interruption in data collection was related to the Christmas holidays and a major blizzard.

Patients who had atrial arrhythmias on admission or who had both CABG and another procedure, such as valve replacement or repair, were not included in the study. The researcher excluded patients if more than 20% of the desired data was missing from their chart. Patients were followed for atrial arrhythmias until discharge or the 10th postoperative day. The 10th postoperative day was selected because there were no atrial arrhythmias documented in the literature beyond this day. Patients who expired before the 10th postoperative day were excluded from the study.

Procedure

The researcher maintained patient confidentiality because the data collection tool contained only the patient's hospital number. The data were maintained by the researcher in a locked file.

Prior to beginning data collection, the researcher notified the cardiothoracic ICU and cardiothoracic stepdown units about the purpose of the study. Several cardiothoracic nurses gave the researcher input about how to find the desired data in the patient's chart.

The researcher visited the cardiothoracic ICU and cardiothoracic stepdown unit at the University of Maryland Medical System at least five times a week to collect all data from post-CABG patient charts. The researcher designed and used the data collection tool (Appendix A) to document the appropriate information from the patient's chart during the patient's hospitalization.

The researcher used the following procedure to record arrhythmias. In accordance with post-CABG protocols, each patient was continually connected to a cardiac monitor with arrhythmia storage capabilities. Any episode of atrial flutter or atrial fibrillation lasting longer than 5 minutes was considered a positive atrial arrhythmia. The postoperative day the atrial arrhythmia first occurred was recorded. If atrial arrhythmias occurred more than once, the earliest episode was recorded.

Pilot Testing

The data collection tool was examined by three cardiac surgical nurse experts to establish its face validity. To establish interrater reliability, the researcher and a cardiac surgical nurse each used the tool to collect data from the same five patient charts. The researcher and the cardiac nurse documented the same information for each of the five patients; therefore, the tool was deemed clear and appropriate.

Protection of Human Rights

The University of Maryland at Baltimore Institutional Review Board reviewed and approved the study (Appendix B). This study was granted exempt status and informed consent was not required.

Data Analysis

Patients were grouped according to whether they developed atrial arrhythmias after CABG. Data were analyzed with an International Business Machine (IBM) personal computer and the Statistical Program for the Social Sciences (SPSS) for Windows software.

Summary statistics described the patients' age, gender, race, and diagnosis.

The following describes the data analyses completed for each research question.

1. What is the incidence of atrial arrhythmias in post-CABG patients?

The incidence of atrial arrhythmias in post-CABG patients was calculated as the percentage of patients who developed atrial arrhythmias postoperatively.

2. Which demographic, preoperative, intraoperative, and postoperative variables predict the development of atrial arrhythmias in the post-CABG patient?

Univariate analyses followed by multivariate analyses were made by forward stepwise logistic regression to identify demographic, preoperative, intraoperative, and postoperative variables that predict atrial arrhythmias after CABG. Univariate analysis included independent means t-tests for interval/ratio data and chi-square tests for categorical data. The following assumptions were met for forward stepwise logistic regression: 1) the sample size was greater than 100 patients, 2) the sample included at least 10 patients per variable, 3) the criterion variable (atrial arrhythmias) was dichotomous data, 4) the predictor variables were either interval/ratio or dichotomous data, and 5) the predictor variables were not highly related to each other (Pedhazur, 1982). Additionally, variables were eliminated from chi-square analysis if there was not five patients in every cell.

Predictor selection began with univariate analysis of each variable. A p value of <0.25 was used for univariate analysis of the variables (Hosmer & Lemeshow, 1984). A more liberal alpha level for univariate analysis accounts for the possibility that a collection

of variables, each weakly associated with the outcome, can become an important predictor during multivariate analysis (Hosmer & Lemeshow; 1989).

All variables significant ($p < 0.25$) by univariate analysis were subjected to multivariate analysis using forward stepwise logistic regression. An alpha of .05 was used as the p level to enter a variable into the model, and a p level of .10 was used to remove a variable from the model once it had been entered. Variables with a p value of $\leq .05$ were identified as multivariate predictors of atrial arrhythmias. An adjusted odds ratio and 95% confidence interval were calculated for all statistically significant variables. The adjusted odds ratio adjusts the estimated effect of each variable in the model for associations among the other variables (Hosmer & Lemeshow, 1989).

A logistic regression model can be statistically significant but not fit the data. A good model is one that produces a high likelihood of the observed data (Norusis, 1993). The overall fit and adequacy of the multivariate logistic regression model was assessed by determining how well the model classified the observed data (Norusis, 1993). The model's chi-square, specificity, and sensitivity were calculated.

3. Is there a significant difference in the average length of hospital and ICU stay for patients who develop post-CABG atrial arrhythmias versus patients who do not develop post-CABG atrial arrhythmias?

The independent means t-test was used to calculate group differences in length of ICU and hospital stay. A p value of $\leq .05$ was considered significant.

4. On which postoperative day are atrial arrhythmias most likely to occur?

The postoperative day that atrial arrhythmias occurred was calculated and reported as the mean and mode.

Chapter IV

RESULTS

The researcher conducted a prospective, descriptive research study to examine the demographic, preoperative, intraoperative, and postoperative factors that predict atrial arrhythmias in the post-CABG patient. This chapter will present the summary statistics for the sample. Second, the data analyses results for each research question are presented. When percentage data are reported in tables in this chapter, the sum does not always equal 100% due to rounding error.

Demographic Variables

The sample consisted of 162 adult CABG patients at the University of Maryland Medical System. All patients who had a CABG operation between October 30, 1995 and December 13, 1995 and between January 12, 1996 and February 17, 1996 were enrolled in the study. The typical patient in this study was a 62-year-old Caucasian male with a diagnosis of coronary artery disease.

Age. The mean age of the sample was 61.57 ± 10.26 years. Patients ranged in age from 31 to 87 years old. Table 1 presents summary statistics regarding age.

Table 1

Summary Statistics of the Sample by Age

Age	N	M	(SD)	Range
Age on day of operation (years)	162	61.57	(10.26)	31-87

Gender. The majority of patients (77.8%) were of male gender. Table 2 presents frequencies and percentages according to gender.

Table 2

Frequencies and Percentages According to Gender

Gender	N	%
Gender		
Male	126	77.8
Female	36	22.2
Total	162	100

Race. Most of the patients (87.7%) were Caucasians. The sample consisted of 20 Black patients; however, no Asian or Hispanic patients were represented in the sample. Table 3 presents frequencies and percentages according to race.

Table 3

Frequencies and Percentages According to Race

Race	N	%
Race		
Caucasian	142	87.7
Black	20	12.3
Asian	0	0
Hispanic	0	0
Total	162	100

Diagnosis. A majority (72.8%) of patients were admitted with a diagnosis of coronary artery disease. Fewer than 11% were admitted with a myocardial infarction, and 9% were admitted with a diagnosis of unstable angina. Table 4 presents frequencies and percentages according to the patient's diagnosis.

Table 4

Frequencies and Percentages According to Admission Diagnosis

Admission Diagnosis	N	%
Diagnosis		
Coronary artery disease	118	72.8
Myocardial infarction	17	10.5
Unstable angina	15	9.3
Chest pain	4	2.5
Angina	3	1.9
Congestive heart failure	2	1.2
Pulmonary Edema	2	1.2
Coronary artery disease and congestive heart failure	1	0.6
Total	162	100

Data Analyses for Each Research Question

The following section includes data analyses results for each research question.

Question 1. What is the incidence of atrial arrhythmias in post-CABG patients?

Of the 162 study patients, 52 (32.1%) developed atrial arrhythmias after CABG. The majority (84.6%) of patients who experienced postoperative atrial arrhythmias developed atrial fibrillation. Eight patients (15.4%) developed both atrial fibrillation and

atrial flutter; however, no patients developed only atrial flutter. The incidence of atrial arrhythmias after CABG and the type of atrial arrhythmias that occurred can be found in Tables 5 and 6, respectively.

Table 5

Frequencies and Percentages According to Postoperative Atrial Arrhythmias After Coronary Artery Bypass Grafting

Postoperative Atrial Arrhythmias	N	%
Subjects with atrial arrhythmias after CABG	52	32.1
Subjects without atrial arrhythmias after CABG	110	67.9
Total	162	100

CABG = coronary artery bypass grafting

Table 6

Frequencies and Percentages According to Types of Atrial Arrhythmias after Coronary Artery Bypass Grafting

Rhythm	N	%
Atrial fibrillation	44	84.6
Atrial flutter	0	0
Atrial fibrillation/flutter	8	15.4
Total	52	100

Question 2. Which demographic, preoperative, intraoperative, and postoperative variables predict the development of atrial arrhythmias in the post-CABG patient? The demographic variable age, and the preoperative variable right coronary artery disease, were significant univariate predictors of postoperative atrial arrhythmias. T-test analyses revealed that patients who developed postoperative atrial arrhythmias were significantly older ($t = 4.45$, $df = 160$, $p = <.001$, two-tailed test) than patients who did not develop these arrhythmias. Chi-square analyses assessed the relationship between a history of right coronary artery disease and postoperative atrial arrhythmias. Patients with a history of right coronary artery disease developed significantly more postoperative atrial arrhythmias ($X^2 = 8.26$, $df = 1$, $p = .007$).

The intraoperative variable number of coronary artery grafts, and the postoperative variable temporary, cardiac pacing approached significance as univariate predictors of postoperative atrial arrhythmias. Patients who developed postoperative atrial arrhythmias received a mean of 3.21 ± 0.8 grafts; patients who did not develop postoperative atrial arrhythmias received a mean of 2.95 ± 0.8 grafts ($t = 1.94$, $df = 160$, $p = .054$, two-tailed test). Temporary, postoperative cardiac pacing approached significance as a univariate predictor of postoperative atrial arrhythmias ($X^2 = 3.61$, $df = 1$, $p = .057$).

Table 7 presents the results of univariate analyses for the demographic, preoperative, intraoperative, and postoperative variables. As can be seen in Table 7, no other demographic, preoperative, or postoperative variables were significant univariate predictors of atrial arrhythmias after CABG.

Table 7

Univariate Analysis of Demographic, Preoperative, Intraoperative, and Postoperative Patient Variables

Variable	Atrial Arrhythmia (n=52)	No Atrial Arrhythmias (n=110)	p Value
Demographic variables			
Mean age (years)	66.13	59.41	<.001*
Male gender	32.5%	67.5%	0.82
Preoperative variables			
COPD	35.3%	64.7%	0.77
Smoking			
Current	28.3%	71.7%	0.66
Past	36.1%	63.9%	0.66
Chronic renal failure	33.3%	66.7%	0.92
Peripheral vascular disease	30.0%	70.0%	0.79
Cardiomegaly	35.7%	64.3%	0.76
Left atrial enlargement	34.4%	65.6%	0.76
Right coronary artery disease	39.4%	60.6%	0.004*
Left ventricular hypertrophy	30.0%	70.0%	0.70
Preoperative digoxin	41.7%	58.3%	0.46
Preoperative beta blockers	33.3%	66.7%	0.67
Intraoperative variables			
Mean number of grafts	3.21	2.95	.054+
Postoperative variable			
Temporary pacing	39.2%	60.8%	0.057+

* = statistically significant = variable subjected to multivariate analysis
+ = $p < 0.25$ = variable subjected to multivariate analysis
COPD = chronic obstructive pulmonary disease, CABG = coronary artery bypass grafting

Because there was not an adequate number of patients in each category, statistical analyses were not performed for the following variables: race, urgency of CABG

operation, use of postoperative beta blockers, postoperative CVA, postoperative ventricular tachycardia, postoperative ventricular fibrillation, and need for a permanent pacemaker. It is interesting to note that no black patients (n = 20) developed atrial arrhythmias after CABG. In addition, data analyses were not completed for preoperative ejection fraction and the number of pack years for smokers because a high percentage of these data were missing.

The following four variables were subjected to forward stepwise logistic regression: age, right coronary artery disease, number of grafts received, and temporary, postoperative cardiac pacing. There were no significant correlations between the variables used for logistic regression. Advancing age was the strongest predictor of atrial arrhythmias post-CABG ($p = .0007$). For every 10-year increase in age, the patient's risk of developing atrial arrhythmias increased 1.93-fold (95% confidence ratio = 1.86-2.00). The presence of right coronary artery disease was also a predictor of post-CABG atrial arrhythmias ($p = .02$). Patients with right coronary artery disease were 2.7 times more likely to have postoperative atrial arrhythmias (95% confidence ratio = 1.14-6.23). The variables number of grafts received and temporary, postoperative cardiac pacing were not significant multivariate predictors of post-CABG atrial arrhythmias. Table 8 presents the results of multivariate analyses.

The model containing age and right coronary artery disease as predictors of post-CABG atrial arrhythmias was assessed for goodness of fit, the probability of the observed results given the parameter estimates (Norusis, 1993). The model was significant by chi-

square analysis ($X^2 = 21.68$, df = 2, p = <.001). Overall, this model was 69.8% accurate in predicting postoperative atrial arrhythmias. The model was 26.9% sensitive in predicting atrial arrhythmias for patients who actually developed these arrhythmias. Finally, the model was 90% specific in predicting which patients did not develop postoperative atrial arrhythmias.

Table 8

Multivariate Analysis of Demographic, Preoperative, Intraoperative, and Postoperative Patient Variables

Variable	Odds Ratio	p Value	95% CI
Age (by decade)	1.93	.0007	1.86-2.00
RCA Disease	2.67	.0231	1.14-6.23

RCA = right coronary artery, CI = confidence interval

Question 3. Is there a significant difference in the average length of hospital and ICU stay for patients who develop post-CABG atrial arrhythmias versus patients who do not develop post-CABG atrial arrhythmias?

Patients who developed atrial arrhythmias had an ICU length of stay of 4.3 ± 7.0 days while patients without atrial arrhythmias had an ICU length of stay of only 2.4 ± 4.1 days. However, this difference in ICU length of stay did not reach statistical significance (p = .08). One patient experienced severe pulmonary, gastrointestinal, and renal complications and stayed in ICU much longer than any other patient. This patient's ICU length of stay was winsorized so that his length of stay was one day longer than the next

highest length of stay. Winsorization is a statistical technique use to handle data that are outliers (Winer, 1971).

Patients who developed postoperative atrial arrhythmias had a significantly (p = .003) longer hospital stay than patients who did not develop postoperative atrial arrhythmias. Patients with atrial arrhythmias were hospitalized 10.5 ± 7.9 days; patients who did not develop atrial arrhythmias were hospitalized 6.8 ± 5.1 days (p = .003). Two patients had much longer lengths of stay than the other patients in the sample. The hospital length of stay for these two patients was winsorized so that their hospital length of stay was one day longer than the next highest length of stay (Winer, 1971). Table 9 summarizes the data for length of ICU and hospital stays.

Table 9

T-Test Analyses for Length of Intensive Care Unit and Hospital Stay after Coronary Artery Bypass Grafting

Length of stay	Atrial Arrhythmia (n=52)	No Atrial Arrhythmias (n=110)	p Value
Mean length of ICU stay (days)	4.25	2.38	.080
Mean length of hospital stay (days)	10.48	6.75	.003

ICU = Intensive care unit

Question 4. On which postoperative day are atrial arrhythmias most likely to occur? The mean onset of post-CABG atrial arrhythmias was 2.5 ± 1.4 days. The postoperative day on which atrial arrhythmias occurred most (32.7%) was postoperative

day two. Atrial arrhythmias occurred on postoperative day two or three for 59.6% of the patients who developed these arrhythmias. Three patients (5.8%) developed atrial arrhythmias on their sixth postoperative day. Table 10 summarizes the frequencies and percentages according to onset of atrial arrhythmias after CABG. Table 11 provides summary statistics of the sample by onset of atrial arrhythmias after CABG.

Table 10

Frequencies and Percentages According to Onset of Atrial Arrhythmias after Coronary Artery Bypass Grafting

Postoperative Day	N	%
Day of surgery	2	3.8
Day one	10	19.2
Day two	17	32.7
Day three	14	26.9
Day four	6	11.5
Day five	0	0
Day six	3	5.8
Total	52	99.9

Table 11

Summary Statistics of the Sample by Onset of Arrhythmias after Coronary Artery Bypass Grafting

Onset of Atrial Arrhythmias	N	M	(SD)	Mode	Median
Onset of Atrial Arrhythmias by postoperative day	52	2.46	(1.35)	2.00	2.00

Chapter V

DISCUSSION

Coronary artery bypass grafting (CABG) is a frequently used and effective procedure to treat coronary artery disease. Atrial arrhythmias are common and may result in complications after CABG, yet the physiologic factors that trigger their onset are poorly understood. The purpose of this descriptive study was to identify demographic, preoperative, intraoperative, and postoperative factors that predict atrial arrhythmias for post-CABG patients. A convenience sample of 162 CABG patients was enrolled in the study. All data were collected from the patient's chart. Summary statistics described the patient's demographic variables. Univariate analyses followed by multivariate analyses were made by forward stepwise logistic regression to identify demographic, preoperative, intraoperative, and postoperative variables that predict atrial arrhythmias after CABG. Two variables, advancing age and right coronary artery disease, were found to predict post-CABG atrial arrhythmias. Patients who developed postoperative atrial arrhythmias had a significantly longer hospital stay than patients who did not develop these arrhythmias. This chapter will provide a discussion of research findings, methodological limitations, conclusions, implications for practice, and suggestions for future research.

Discussion of Research Findings

The following provides a discussion of the results for each research question.

Question 1. What is the incidence of atrial arrhythmias in post-CABG patients?

Of the 162 patients in the sample, 52 (32.1%) developed postoperative atrial arrhythmias. Other researchers have reported that 5-50% of CABG patients developed atrial arrhythmias postoperatively (Lauer et al., 1989; Cox, 1993; Leitch et al., 1990; Lowe et al., 1991; Steinberg et al., 1993; Dixon et al., 1986; Rubin et al., 1987). The findings from this study are within the range reported by other researchers and are similar to the post-CABG atrial arrhythmia incidences of 28.4%, 29%, and 31.9% reported by Fuller et al. (1989), Crosby et al. (1990), and Creswell et al. (1993), respectively.

Question 2. Which demographic, preoperative, intraoperative, and postoperative variables predict the development of atrial arrhythmias in the post-CABG patient?

Advancing age was found to be the strongest multivariate predictor of atrial arrhythmias after CABG. This finding is consistent with the results of previous researchers who identified advancing age as the strongest predictor of postoperative atrial arrhythmias (Fuller et al., 1989; Leitch et al., 1990; Frost et al., 1992; Mendes et al., 1995; Creswell et al., 1993). As the heart ages, structural changes occur and may place the patient at increased risk for arrhythmias (Creswell et al., 1993).

Right coronary artery disease also was found in this study to predict post-CABG atrial arrhythmias. Mendes et al. (1995) were the only researchers to study and demonstrate that right coronary artery disease predicts atrial arrhythmias after CABG. Researchers are not certain about the mechanism by which right coronary artery disease predisposes patients to atrial arrhythmias. Mendes and associates (1995) suggested that right coronary artery disease causes ischemia which leads to right ventricular dysfunction.

Because the right coronary artery also supplies blood to the right atrium, right atrial dysfunction may occur and contribute to post-CABG atrial arrhythmias.

Although the above findings from this present study support previous research results, investigators have reported conflicting results regarding other variables. Some researchers have identified male gender as a predictor of post-CABG atrial arrhythmias (Fuller et al., 1989; Mendes et al., 1995; Creswell et al., 1993). In contrast, Steinberg et al. (1993) did not find that gender predicted atrial arrhythmias post-CABG. The present study contained a small number of women and may be the reason statistical significance was not achieved.

Leitch and associates (1990) are the only researchers who evaluated whether a history of chronic renal failure predicts atrial arrhythmias after CABG. While they found that chronic renal failure predicts atrial arrhythmias after CABG, the findings of the present study did not support their results. Only a small number of patients in the present study had chronic renal failure; therefore, it was difficult to achieve statistical significance. A history of chronic obstructive pulmonary disease predicted post-CABG atrial arrhythmias for patients in studies by Creswell et al. (1993) and Leitch et al. (1990). Mendes et al. (1995) did not identify COPD as a predictor of post-CABG atrial arrhythmias. In the present study, COPD was not found to predict post-CABG atrial arrhythmias and this is likely due to the small numbers of patients who had a history of COPD.

The results of the present study did not identify history of cardiomegaly or history of left atrial enlargement as predictors of atrial arrhythmias after CABG. Dixon et al. (1986) found that patients with atrial arrhythmias after CABG had a significantly higher prevalence of cardiomegaly and left atrial enlargement; however, they did not use multivariate analyses to analyze whether cardiomegaly and left atrial enlargement *predict* atrial arrhythmias after CABG.

The use of preoperative digoxin was not identified as a predictor of post-CABG atrial arrhythmias. This result may be influenced by the smaller sample size. Creswell et al. (1993) found that the use of preoperative digoxin predicts post-CABG atrial arrhythmias; however, their finding was not supported by Fuller et al. (1989).

The finding in the present study that a history of smoking does not predict atrial arrhythmias after CABG is in agreement with the finding by Dixon et al. (1986). Creswell and associates (1993) are the only researchers to document that a current smoking habit predicts post-CABG atrial arrhythmias ($p < .05$). The reason for the finding by Creswell et al. may be accounted for by their sample size of 2,833 patients. By comparison, the sample size for the present study was much smaller.

In a study by Steinberg and colleagues (1993), a history of left ventricular hypertrophy predicted post-CABG atrial arrhythmias; however, the present study did not support this finding. It is possible that patients in the present study have a different clinical profile than patients in the Steinberg et al. study.

Creswell et al. (1993) were the only researchers known to this researcher who reported that a history of peripheral vascular disease predicts post-CABG atrial arrhythmias. The findings of the present study do not support their findings. In the present study, only a small number of patients had a history of peripheral vascular disease; therefore, it was difficult to achieve statistical significance.

In the present study, postoperative, temporary cardiac pacing was not identified as a predictor of atrial arrhythmias after CABG. No other researchers have studied this variable.

No previous researchers have identified the number of grafts as a predictor of post-CABG atrial arrhythmias (Dixon et al., 1986; Fuller et al., 1989; Mendes et al. 1995). The findings of the present study support these previous results.

Research regarding preoperative beta blockers are inconclusive. Yousif et al. (1990) found that preoperative beta blockers protected patients from postoperative atrial arrhythmias; however, Leitch and colleagues (1990) found that the use of preoperative beta blockers predicts the incidence of post-CABG atrial arrhythmias. In the present study, the use of preoperative beta blockers did not predict post-CABG atrial arrhythmias. The use of preoperative beta blockers for patients in the present study was not standardized, thus the patient's physician determined whether or not the patient received preoperative beta blockers.

Chi-square statistical analyses were not performed for race because there were not at least five patients in every cell. It is interesting to note that no Black patients developed

post-CABG atrial arrhythmias. This finding is likely related to the small number of Black patients in the sample. Creswell et al. (1993), the only researchers to examine race as a predictor of postoperative atrial arrhythmias, found that race did not predict postoperative atrial arrhythmias after CABG.

Question 3. Is there a significant difference in the average length of hospital and ICU stay for patients who develop post-CABG atrial arrhythmias versus patients who do not develop post-CABG atrial arrhythmias?

Patients who developed postoperative atrial arrhythmias had a significantly longer total hospital stay than patients who did not develop these arrhythmias. Patients with postoperative atrial arrhythmias had a mean length of stay of 10.48 ± 7.9 days, while patients without atrial arrhythmias had a mean length of stay of 6.75 ± 5.1 days. This finding supports previous research by Creswell et al. (1993) and Mendes et al. (1995) who also found that patients with postoperative atrial arrhythmias had a significantly longer hospital stay.

While patients who developed postoperative atrial arrhythmias stayed in ICU nearly two days longer than patients without atrial arrhythmias, this difference was not statistically significant. This nonsignificance may be related to the fact that several patients without atrial arrhythmias had longer ICU length of stay related to complications such as sepsis, renal failure, and gastrointestinal bleeding. The findings from this study do not support previous research findings by Creswell et al. (1993) and Lowe et al. (1991)

who reported that ICU length of stay is significantly longer for patients who develop atrial arrhythmias after CABG.

Although the difference for length of ICU stay was not statistically significant, four additional days in the hospital, including two additional days in ICU, represents a substantial increase in cost. For the University of Maryland Medical System, two additional days in ICU costs an estimated $5000 (Sherry Perkins, personal communication, April 15, 1996). Furthermore, it costs $1250 for each additional day a patient stays in the intermediate care unit (Sherry Perkins, personal communication, April 15, 1996). Therefore, for patients in this study who developed atrial arrhythmias, the additional length of ICU and hospital stays cost nearly $7500.

Question 4. On which postoperative day are atrial arrhythmias most likely to occur?

The mean onset of post-CABG atrial arrhythmias was 2.5 ± 1.4 days. The postoperative day on which atrial arrhythmias occurred most (32.7%) was postoperative day two. Atrial arrhythmias occurred on postoperative day two or three for 59.6% of the patients who developed these arrhythmias. Three patients developed postoperative atrial arrhythmias on postoperative day six. These findings are consistent with the results of previous research. Fuller et al. (1989) found that the largest percentage of patients developed atrial arrhythmias on the second postoperative day. In a study by Steinberg and associates (1993), the majority of atrial arrhythmias occurred on postoperative day two or three. Yousif et al. (1990) and Steinberg et al. (1993) reported that patients developed post-CABG atrial arrhythmias as late as the eighth to tenth postoperative day.

The physiologic mechanism that accounts for the delay in the onset of post-CABG atrial arrhythmias is poorly understood. Because post-CABG arrhythmias often occur on the second postoperative day, Fuller and associates (1989) suggested that atrial edema, pericarditis, or reperfusion injuries may cause these arrhythmias. It will be interesting to note whether patients who undergo minimally invasive bypass surgery develop postoperative atrial arrhythmias and if so, on which postoperative day the arrhythmias occur.

Methodological Limitations

This descriptive study has limitations; therefore, the results must be viewed with caution. First, the researcher did not have any influence over protocols or surgical techniques. The results could be related to diverse preoperative, intraoperative, or postoperative patient care management as determined by individual physician preference. Second, the researcher collected all data by prospective chart review. If the chart's information was inaccurate, the results of this study are questionable. Third, though not likely because of continuous monitoring, it is possible that some patients with undetected or undocumented atrial arrhythmias did have atrial arrhythmias. Fourth, the researcher calculated multiple chi-square and t-tests on the same data, thus increasing the risk of a Type I error. Finally, though acceptable, the sample size was minimal for logistic regression analyses.

Conclusions and Applications

These results suggest that advancing age and the presence of preoperative right coronary artery disease may be important predictors of patients who develop post-CABG atrial arrhythmias. Patients who developed post-CABG atrial arrhythmias had a significantly longer length of hospital stay.

The results of this study have implications for cardiothoracic critical care and stepdown unit nurses. First, as cardiothoracic nurses plan care for CABG patients, they need to carefully assess the patient's age and history of right coronary artery disease. Nurses should assess the patient's age and history of right coronary artery disease as part of the preadmission assessment. Nurses should carefully monitor patients with advanced age or right coronary artery disease for postoperative atrial arrhythmias, paying special attention to the second and third postoperative day, the days these arrhythmias are most likely to occur. Second, cardiothoracic nurses can collaborate with physicians to evaluate whether patients at high risk for post-CABG atrial arrhythmias would benefit from prophylactic antiarrhythmic therapy. Third, because these arrhythmias may occur after discharge, cardiothoracic nurses need to educate patients about the potential for atrial arrhythmias. Patient education includes how to monitor one's pulse rate and rhythm, the symptoms associated with atrial arrhythmias, and what actions to take should the patient suspect he or she is experiencing atrial arrhythmias.

These results also are significant to home health care nurses. Postoperative CABG patients are discharged as early as the third postoperative day and then receive visits from a home health care nurse. Patients may experience an uncomplicated hospital stay only to

develop postoperative atrial arrhythmias after discharge. Hospital nurses need to inform home health care nurses about the patient's health history and whether or not the patient had atrial arrhythmias while hospitalized. Home health care nurses need to assess post-CABG patients for atrial arrhythmias by carefully listening to heart sounds for rate and regularity. Additionally, home health care nurses should question the patient for evidence of any symptoms common with atrial arrhythmias such as palpitations, dizziness, and lightheadedness. If available, the home health care nurse should document the patient's cardiac rhythm via a portable cardiac monitor or electrocardiogram. The nurse needs to inform the patient's physician if atrial arrhythmias are suspected.

Finally, these results impact managed care personnel, discharge coordinators, utilization managers, and health care personnel who develop clinical pathways. Case managers and discharge coordinators can anticipate that patients at risk for atrial arrhythmias may have a higher incidence of postoperative complications and a longer hospital stay. Clinical pathways for patients who develop atrial arrhythmias will prevent delays in timely therapy, reduce complications, and minimize extended hospital stays.

Suggestions for Future Research

Many researchers have attempted to definitively identify the predictors of atrial arrhythmias after CABG. This study adds to the current body of knowledge regarding this issue; however, more research is needed to identify the best model that predicts atrial arrhythmias post-CABG. Questions for future research include the following:

- Can a P-wave signal-averaged ECG predict atrial arrhythmias for postoperative CABG patients?
- Is there a difference in the incidence of atrial arrhythmias after CABG for patients who receive warm versus cold cardioplegia intraoperatively?
- What is the minimal time postoperative CABG patients should remain on continuous cardiac monitoring?
- What is the relationship between the CABG patient's postoperative fluid and electrolyte balance and the development of postoperative atrial arrhythmias?
- What is the relationship between temporary, postoperative cardiac pacing and the development of postoperative atrial arrhythmias for CABG patients?
- What is the relationship between the number of grafts that a CABG patient receives and the development of postoperative atrial arrhythmias?
- Which prophylactic protocols are most effective in preventing atrial arrhythmias after CABG?
- Do CABG patients exhibit any specific clinical manifestations prior to the onset of postoperative atrial arrhythmias?
- What is the most effective way to teach postoperative CABG patients to self-monitor for atrial arrhythmias after discharge?
- Within one month of discharge, how many CABG patients require readmission to the hospital for atrial arrhythmias?

- Of the CABG patients who develop postoperative atrial arrhythmias during hospitalization, how many patients require readmission for recurrent atrial arrhythmias?
- What is the incidence of post-CABG atrial arrhythmias for patients who undergo minimally invasive bypass surgery?

Appendix A

Data Collection Tool

Appendix A

Data Collection Tool

Demographic Data

Patient's ID Number: _____

Gender: (1) Male _____

(2) Female _____

Age in years on day of surgery: _____

Race: (1) Caucasian _____

(2) Black _____

(3) Asian _____

(4) Hispanic _____

(5) Other (specify) _____

Diagnosis: _____

Date of Admission: _____

Preoperative Data

History of COPD: (1) Yes _____

(2) No _____

History of cigarette smoking: (1) Current Smoker _____

Number of pack years _____

(2) Past Smoker _____

Number of pack years _____

(3) No _____

History of chronic renal failure: (1) Yes _____

(2) No _____

History of peripheral vascular disease: (1) Yes _____

(2) No _____

Radiographic cardiomegaly: (1) Yes _____

(2) No _____

Left atrial enlargement: (1) Yes _____

(2) No _____

Left Ventricular Ejection Fraction by cardiac catheterization: _____%

RCA disease ≥ 70% narrowing of the RCA proximal or mid segment: (1) Yes _____

(2) No _____

Left ventricular hypertrophy: (1) Yes _____

(2) No _____

Preoperative use of digoxin: (1) Yes _____

(2) No _____

Preoperative use of beta blockers: (1) Yes _____

(2) No _____

Urgency of CABG operation: (1) Emergent _____

(2) Elective _____

Intraoperative Data

Date of Surgery: _____

Number of grafts performed: (1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

(> 6) (specify) _____

Postoperative Data

Postop atrial arrhythmias: (1) Yes _____

Type: (1) Atrial fibrillation _____

(2) Atrial flutter _____

Date/time atrial arrhythmia occurred: _____

Postop day atrial arrhythmia occurred: (1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

(7) _____

(8) _____

(> 8) ____(specify)

Atrial arrhythmia confirmed with 12 lead EKG (1) Yes ___

(2) No ___

(2) No _____

Postoperative Beta-Blocker therapy: (1) Yes _____

Drug: _____

Time Initiated _____

(2) No _____

Cerebral vascular accident: (1) Yes _____

(2) No _____

Ventricular tachycardia: (1) Yes _____

(2) No _____

Ventricular fibrillation: (1) Yes _____

(2) No _____

Temporary pacing: (1) Yes _____

(2) No _____

Permanent pacing: (1) Permanent Pacemaker _____

(2) AICD/Pacemaker _____

(3) No Permanent pacemaker _____

Date of Discharge: _____

Length of stay:

(1) 1 day _____

(2) 2 days _____

(3) 3 days _____

(4) 4 days _____

(5) 5 days _____

(6) 6 days _____

(7) 7 days _____

(8) 8 days _____

(9) 9 days _____

(10) 10 days _____

(11) > 10 days (specify) _____

ICU length of stay:

(1) 1 day _____

(2) 2 days _____

(3) 3 days _____

(4) 4 days _____

(5) 5 days _____

(6) 6 days _____

(7) 7 days _____

(8) > 7 days (specify) _____

Appendix B

Letter of Exemption From the Institutional Review Board

University of Maryland Medical Center

UNIVERSITY OF MARYLAND
SCHOOL OF MEDICINE

OFFICE OF THE DEAN
Office for Research Subjects

655 West Baltimore Street, Room 14-016.BRB
Baltimore, Maryland 21201-1559
Voice: 410 706-5037
Fax: 410 706-4189
Email: ORS@SCHMED01.AB.UMD.EDU

MEMORANDUM

TO: Marla DeJong, Principal Investigator
Patricia Gonce Morton, Thesis Advisor

FROM: UMAB Institutional Review Board (IRB)
Assurance Number M1174-01NR

RE: "Patients at risk for atrial arrhythmias after coronary artery bypass grafting"
(Thesis Proposal)
EXEMPTION No. PM10952

DATE: October 24, 1995

The above-referenced project has been reviewed and determined to be exempt from the IRB approval process according to the Department of Health and Human Services Office for Protection from Research Risks Code of Federal Regulations 45 CFR 46.101.b (4).

If the protocol is altered in any way, it must be reviewed by the IRB.

Please keep a copy of this letter for future reference. If you have any questions, please do not hesitate to contact the IRB Office at (410) 706-5037.

Robert R. Conley, MD, Chairman
Institutional Review Board

CC: IRB Exemption File

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